## Remarks

Summary of the Amendment of the Claims

Claims 1, 28, 29 and 30 have been amended to require that the liquid distributor is a *closed* system. Support for this amendment can be found, for example, on page 15, lines 2 to 3. In addition, these claims have also been amended to require that the primary distribution zone and/or the or each secondary distributor is at least partially filled with packing. Support of this amendment can be found, for example, in Claims 12 and 13 as filed and on page 12, lines 27 to 32. Finally, these claims have also been amended to remove the reference to the "characteristic length" criteria being the characterizing features of the invention.

Claim 8 has been amended to delete the reference to "the or" as requested by the Examiner.

Claims 12 and 13 have been cancelled as they are redundant over new Claim 1.

Claim 16 is mistakenly self-dependent as a result of a typographical error. The dependency of Claim 16 has been corrected so that the claim is dependent from Claim 15. Such correction is obvious as Claim 15 is the only claim that provides the necessary antecedent basis for the features of Claim 16.

New Claim 31 has been introduced and covers a method of producing a liquid distributor. A key feature of the present invention appears to be the fact that the Inventors first consider the thermodynamic nature of the separation to be achieved and then design the distributor specifically for that separation. I have re-drafted Claim 1 as filed to convert the apparatus features into method features. Support for the remaining method features is at least implicit if the whole of the teaching of the specification is considered and, in particular, can be found, for example, on page 9, line 28 to page 11, line 30.

New Claim 32 has been introduced and covers embodiments of the method of new Claim 31 in which the arrangement of distribution apertures is tailored to co-operate with a specific arrangement of structured packing in the column. Support for this amendment can be found, for example, on page 14, lines 14 to 20.

No new matter is added by the foregoing amendments.

No further amendments have been made to the claims.

Priority - § 119(b)

The Examiner notes that a certified copy of the priority document (EPA 02255310.1) has not been filed. The certified copy of the priority document was filed with the application on 14 July 2003 as evidenced by the attached copy of the USPTO stamped postcard receipt. The Examiner is requested to recheck the USPTO files to determine whether the priority document needs to be refilled.

The § 112 Rejection

The Examiner rejected Claims 1-27, 29 and 30 under 35 USC 112, second paragraph, as being indefinite for failing to point out and distinctly claim the subject matter that Applicants regards as the invention.

The Examiner states that the expression "all angles of tilt" includes 90° from the vertical. Applicants do not believe that the person skilled in the art of off shore vapor/liquid separation column design would agree. In contrast, the skilled person would understand that use of the term "tilt" in the context of the present application implies that there is a maximum inclination of tilt, e.g. that expected from normal sea motion. In this connection, whilst the present application makes no specific reference to a particular maximum angle of inclination, it does refer to a "maximum *expected* angle" (see, for example, page 10, line 14). It is known in the art that off shore columns are generally subjected to angles of inclination of up to ±12° (see, for example, US-A-6149136 (column 5, lines 56 to 58) and US-B-6294053 (column 4, lines 37 to 39) of the cited references and US-A-5984282 (column 7, lines 44 to 47) and EP-A-0930088 (column 6, lines 38 to 40)). Therefore, the skilled person would understand that the expression "all angles of tilt" implies all angles of tilt up to about ±12°.

The Examiner states that "flow will be *equal*, for all angles of tilt" (emphasis added). With respect, this is not correct. It is clear from the disclosure and common general knowledge that flow through the apertures will not be equal for all angles of tilt. In contrast, new Claim 1

actually requires that the *difference* in flow rate between the aperture having the maximum liquid flow and the aperture having the minimum liquid flow in the or each secondary distributor at each angle of tilt be less than a second predetermined maximum for all angles of tilt. Clearly, we do not anticipate liquid flow being equal through all the apertures unless the column is vertical.

The Examiner objects that the first and second predetermined maxima are not defined and that therefore the maxima could be near infinite. New Claim 1 requires that the maxima be determined by the required degree of vapor liquid separation. Thus, the values of the maxima are defined by the nature and efficiency of the separation. Therefore, it is difficult to "define" the maxima generally any further in the claims. That said, the skilled person is given sufficient information in the description to calculate the maxima for a given separation (see page 9, line 10 to page 11, line 20). According to page 11, line 10 to 20:

> "...(i)f the size of the or each secondary distributor is less than the characteristic length, the flow rate of all the streams leaving the distributor will be within the acceptable standard deviation of flows when the column is tilted. The acceptable standard deviation of flows is determined by the thermodynamic difficulty of the separation; some separations are more difficult than others and will require more uniform liquid distribution. **This can be determined from the approach of the operating line to the equilibrium line for the separation being considered** (Step 1). **Once the operating line intersects the equilibrium line the separation stops** (Step 2). **Therefore, the standard deviation of the flows and the relative difference between any two apertures is acceptable when the gradient of the operating line can be changed by that amount but would not result in the operating line crossing the equilibrium line** (Step 3)..." (emphasis added)

This passage in particular provides the skilled person with step-by-step instructions regarding how go about calculating these maxima, viz.:

> Step 1 – The skilled person would look at the specific separation and operating conditions using an 'x-y' plot which is a general plot showing the relationship between the vapor and liquid compositions and is either drawn by hand or created by a simulation program. This kind of plot is commonly known as a "McCabe-Thiele" plot.

Step 2 – The skilled man would know that once the operating line crosses the equilibrium line then separation stops and so this must always be avoided. The skilled person would know to try and avoid getting the operating line too close to the equilibrium line to allow for minor flow variations.

Step 3 – The skilled person would know that, for many separations, one should have an operating line well away from the equilibrium line. Reducing the distribution quality means that the operating line will become a "band" (as there will be a range of flows from higher to lower) but as long as the edges of the band do not cross the equilibrium line at any point then separation will still occur, albeit with some reduction in the efficiency of separation. For example, if the distribution quality is +/-2% then as long as the gradient of the operating line can be changed by +/-2% then at no point in the column will the separation stop.

The Examiner's objections to the clarity of Claims 8 and 16 have been overcome by the above-mentioned amendments to these claims.

The Examiner believes that the embodiment defined in Claim 21 cannot function as claimed. New Claim 1 requires that the liquid distributor is a closed system. It is, therefore, implicit that conduits are provided between the openings in the bottom of the primary distribution zone and the secondary distributors. The skilled person would clearly appreciate that the embodiment of Claim 21 when dependent from Claim 20 would function as claimed.

The § 102 Rejection

In the Office Action the Examiner rejected Claims 1-4, 6-10, 12, 19, 20, 25 and 28-30 as being anticipated by US-A-4565216 (Meier); Claims 1-4, 6-9, 11, 14, 17, 19, 20, 25, 29 and 30 as being anticipated by US-A-6149136 (Armstrong *et al*), Claims 1-3, 5, 12, 13, 17, 18, 20, 22-27, 29 and 30 as being anticipated by US-B-6294053 (Darredeau *et al*), Claims 1-5, 17, 18, 20, 22, 23, 25-27, 29 and 30 as being anticipated by US-B-6395138 (Darredeau *et al*) and Claims 1-4, 6-8, 10, 17, 18, 20, 22, 23 and 25-30 as being anticipated by US-A-4472325 (Robbins). The Meier, Armstrong and both Darredeau references are all acknowledged in the present application.

Meier discloses (see column 1, lines 6 to 9) a liquid distributor for mass and heat transfer columns. There is a reference (see column 2, line 18) to the distributor being inclined, e.g. by 0.5% to the horizontal. The exemplified distributor has flow channels 5 that deliver liquid to the feed pipes 6a of individual tube distributors 6. It is apparent from the figures that the distributor is an open system as the ends of flow channels 5 are not joined to the feed pipes 6a.

In the embodiment depicted in Figure 4, a pair of static mixers 11 (of the type disclosed in Swiss patent No. 537208) is located in the primary distributor. The disclosed purpose of the static mixers is to mix liquids from different sources prior to distribution. Meier does not disclose that such mixers dampen down liquid movement induced by movement of the distributor.

There is no disclosure in Meier of the distributor being used in conjunction with a *tiltable* column. For example, there is no disclosure of the distributor being used offshore. It appears, therefore, that the purpose of the distributor in Meier is to correct any maldistribution of liquid in a static column that might have otherwise been observed due to the column having been erected at a small but permanent angle of inclination. In addition, Meier does not disclose a *closed system* liquid distributor.

Armstrong discloses (see column 1, lines 5 to 10) a distributor for use off shore with vapor/liquid contact columns such as cryogenic air separation columns. The distributor is a two stage distributor consisting of a primary distributor (viz. a header tank and conduit means) and a secondary distributor (viz. a distribution plate) (see column 2, lines 55 to 58). The secondary distributor consists of a large number of individual reservoir cells and the primary distributor feeds liquid individually into each cell (see column 2, lines 60 to 63). According to the figures, the primary distributor comprises a header tank 1 in communication with a plurality of pipe branches 3. Each pipe branch 3 has a series of spaced delivery tubes 7 individually aligned with a respective reservoir cell 4 of the secondary distributor. It is disclosed (see column 4, lines 29 to 30) that each cell is usually open at its top.

There is no disclosure in Armstrong of the use of packing in the primary or secondary distributor.

Darredeau '138 and '053 both disclose (see column 1, lines 6 to 9) a liquid distributor for use with air distillation columns on board floating structures. In the embodiment exemplified in both references, the distributor consists of a primary distributor 3 and a secondary distributor 4 arranged underneath. The primary distributor is a pipe distributor and the secondary distributor is in the form of an open dish having a number of discrete compartments, each compartment having a number of apertures provided in the base.

Darredeau '053 discloses that each compartment 22 (of the secondary distributor) may be equipped with means for remixing the liquid, for example, inclined partitions descending the wall 16, as is known per se. This is not a disclosure of the use of packing to dampen down liquid movement due to movement of the distributor. The skilled person would understand that such inclined partitions would not function to dampen down liquid movement. In contrast, such partitions would simply change direction of the movement of the liquid.

Darredeau '138 does not disclose any means provided in the secondary distributor, let alone means for dampening down liquid movement.

Neither Darredeau '138 nor Darredeau '053 discloses a *closed system* distributor.

Robbins discloses (see column 1, lines 6 to 8) an apparatus for distributing a liquid across the packed bed of a vapor-liquid contact column. The primary problem addressed by the apparatus in Robbins is to overcome liquid maldistribution in larger static columns that might be permanently inclined (see column 1, lines 56 to 68). There is a reference to the column shifting (see column 1, line 65) but the skilled person would understand that Robbins is referring to movement as the column settles after erection. It is disclosed (see column 2, lines 11 to 12) that the apparatus is made up of a distributor unit and a parting manifold. The distributor unit consists of a plate and several up standing walls which are fastened along one edge to the plate (see column 2, lines 13 to 15). One of the upstanding walls defines the periphery of the plate and the other walls are positioned both crosswise and lengthwise of the plate to define separate, open-top compartments within the distributor unit (see column 2, lines 15 to 19).

Robbins does not disclose a distributor for use in conjunction with a *tiltable* column, e.g. for use off shore. In addition, Robbins does not disclose a *closed system* liquid distributor.

Further, Robbins does not disclose the use of packing in either the primary or the secondary distributor.

As none of the cited references discloses a *closed* system liquid distributor in which at least one of the primary distribution zone and the or each secondary distributor is at least partially filled with packing, the present invention as defined in new independent Claims 1 and 28 to 30 is novel over the disclosures of the cited references. The subject matter of Claims 2 to 11 and 14 to 27 is novel by virtue of the dependency of these claims from the new independent Claim1.

None of the cited references makes any reference to the method by which the distributors are produced. There is no disclosure in any of the references of taking the thermodynamic difficulty of separation into account before designing the distributor. Therefore, the method of new Claims 31 and 32 is novel over all of the cited references.

In addition to being novel over the cited art, Applicants submit that the claims as amended are not obvious over the cited art.

The problem addressed by the present invention is to reduce maldistribution of liquid in a vapor liquid separation column for use off shore. The solution proposed by the present invention is the use of apparatus as defined in new Claim 1 in which the liquid distributor is a closed system and is at least partially filled with packing to dampen down liquid movement.

First, none of the cited references is concerned with closed system liquid distributors for use off shore.

The Examiner believes that the skilled person would consider the static mixer disclosed in Meier and the means for mixing (or inclined partitions) disclosed in Darredeau '053 to be "packing" to dampen down liquid movement in a distributor. I do not think that this is correct.

The purpose of mixing means is to force liquids to mix together. A static mixer is an example of such means which does not use moving parts to cause mixing of the liquids. Instead, a static mixer has a plurality of defined intersecting channels through which the liquid

flows and is mixed. The channels may be defined by a series of inclined partitions. Such a mixer is indicated in Darredeau '053. In any event, mixing is achieved by *increasing liquid movement* in such a manner that the liquid mixes.

The purpose of the packing in the distributor of the present invention is to *dampen down* movement of the liquid. Therefore, when presented with the problem of reducing the amount of movement of liquid in a distributor, the skilled person would not consider using mixing means as disclosed in either Meier or Darredeau '053 as these references teach away from *reducing* liquid movement and, in contrast, disclose *increasing* liquid movement such that the liquid mixes.

Secondly, therefore, none of the references cited by the Examiner discloses the use of packing to dampen down liquid movement in a distributor.

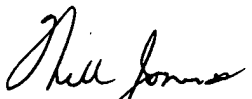
No combination of the cited references results in apparatus falling within the scope of new Claim 1, a liquid distributor within new Claim 28, a tiltable platform within the scope of new Claim 29 or a use of apparatus within the scope of new Claim 30. Therefore, the invention as defined by these claims (and the claims dependent thereto) has an inventive step of each of the cited references, when considered alone or in any combination.

Historically, liquid distributors have always been designed to provide the best possible distribution at a reasonable cost and the cited references follow this trend. In contrast, it is a requirement of the methods of Claims 31 and 32 that the thermodynamic nature of the separation is considered first, i.e., one explicitly calculates what is actually required for the specific separation and then designs the distributor to meet the requirements. As it is not possible to derive this approach from any combination of the cited references, the methods of Claims 31 and 32 also have an inventive step over each of the cited references, when considered alone or in any combination.

Conclusion

For all of the foregoing reasons, Applicants submit that all of the pending claims, as amended, are patentable over the art of record. Withdrawal of the objections is respectfully requested and an early Notice of Allowance is earnestly solicited.

Respectfully submitted,



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